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A Quantitative and Qualitative Review of the Role of Intelligent Transportation Systems in Road Safety Studies through Three Decades

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ABSTRACT

Road safety is an important subject to study in both the technical and academic fields of road transportation. In recent years, there has been a significant rise in the number of studies that look at how intelligent transportation systems (ITS) can be used and what role it plays in making roads safer in different countries. Nevertheless, there are still relatively few in-depth quantitative and qualitative analyses published on the topic of ITS's role in ensuring road safety. For this purpose, the main goal of this study is to look at a thorough quantitative and qualitative analysis of how ITS is used in road safety as a part of transportation engineering. In this study, we reviewed the scientific studies done on the use of ITS in studies of road safety from 1990s to 2022. These studies were published in journals or presented at conferences that were part of the Web of Science (WoS) Index. The analysis in this study gives a thorough map of the field, showing how it has changed over time and pointing the way to new areas of research.

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1. Introduction

The safety of most people on the roads is one of the main goals of transportation policy. So, when planning, constructing, and operating roads and streets, safety is a top priority. The importance of safety in everyday actions like driving reflects its place as an integral part of human life [1–6]. "Road safety" means the steps that are taken before an accident to make sure everyone is safe and to lessen the severity of any injuries or deaths that might happen. One common measure of road safety is the number of fatalities and injuries that have been avoided [7–10]. In fact, one might argue that the number of deaths and injuries on the roads is inversely proportional to how safe the roads are. When trying to make roads as safe as possible, it's important to have a full understanding of the problem at hand, as well as a full understanding of all the important parts and an estimate of how much each one matters [11–14]. Many valuable studies have been done in the field of road safety due to the importance of the issue [15–20]. Bassani et al., (2020) analyzed data on VRU-related traffic accidents in Turin between 2006 and 2016. The Italian National Institute of Statistics' (ISTAT) database of transportation road accidents was utilized in their geographical distribution study. Data pertaining to crashes was geolocated and then analyzed using tools from a geographic information system. Space-time distributions of VRU-involved collisions were constructed using cluster analysis and a kernel density estimate. According to their results, concentrations were most common near intersections. Also, many of these were located along high-traffic corridors with significant cross-sections [21]. To confirm and expand the use of driving simulators for analyzing two-lane road safety, Karimi et al., (2020) investigated passing behavior in passing zones. Fifty-four volunteers participated in different traffic situations on a two-lane rural highway segment in validation research using a fixed-base interactive simulator. After conducting a drone survey of the actual section to record videos and extract data on actual passing operations, a 3D model and its environmental features were generated. In the two-tailed K-S test, the acceptable gap, the effectively accepted gap, the perceptual response time, and the time to the collision were all the same between the field and the simulator at a 95% confidence level [22]. Bauernschuster, and Rekers (2022) investigated how speed limit monitoring operations (SLMO) that were only planned to last a single day affected motorist safety. Media efforts warning the public about the perils of speeding accompanied SLMO. Using registration data on police-reported incidents in a generalized difference-in-differences technique, the results showed that SLMO reduces traffic accidents and deaths by 8%. However, after the SLMO day, none of the effects remain. Moreover, there is evidence to show that individuals drive more slowly and responsibly on SLMO days in order to avoid penalties; no change in driver behavior was seen despite efforts to educate speeders on the risks of speeding [23].

Since the end of the last century, many researchers have investigated the effectiveness of simulation and traffic conflict techniques for road safety analysis [1,24–30]. Laureshyn et al. proposed a framework for putting all traffic encounters into a severity hierarchy based on some operational severity measure. They suggested that a set of indicators based on small-scale behavioral data be used to describe an encounter [31]. Guido et al. focused on the analysis of road safety from two different perspectives: microsimulation and observational data. Using a technique for processing video images, they compared a set of safety performance indicators from an experimental case study to see how well microsimulation matched "real" driver behavior and traffic conditions [32].

Several studies have concentrated on the analysis of road safety through traffic flow simulation in road network intersections, which are notorious for having the highest number of accidents. Essa and Sayed developed conflict-based safety performance functions (SPFs) for signalized intersections at the signal cycle level using the generalized linear models (GLM) approach [33]. In 2019, a comparison of different micro-simulation models for evaluating safety at intersections has been presented by Astarita et al. [34]. Gallelli et al. proposed a method for calibrating and validating a simulation model capable of reproducing observed vehicle conflicts at roundabouts [35]. Mishra et al. showed how video analytics can be used to find both pedestrian–vehicle conflict hotspots and vehicle–vehicle conflict hotspots at road intersections [36].

Many researchers use a variety of methods and systems to increase road safety. Researchers are now using traffic simulation to figure out how intelligent transportation systems (ITS) affect road safety [37–39]. ITS is one of the most important technological systems in the field of transportation. Intelligent transportation systems are high-tech programs that help users learn more and use transportation networks in a safer, more coordinated, and "smarter" way by offering new services related to different kinds of transportation and traffic control. In fact, it was made by transportation engineers with the help of experts in fields like telecommunications and communications, electronics, computers, etc., using the information technology of intelligent systems [40,41]. Technology and science have grown a lot in the last few decades and are still improving. Also, with significant advances in artificial intelligence and hardware technologies, the performance of intelligent systems and their analysis have improved in many fields [42–51]. The ITS has improved safety and sustainable mobility by using technologies like measuring, analyzing, controlling, and communicating [52,53].

Several valuable literature studies on ITS and road safety have been published. Some of them have been broad in scope, while others have concentrated on particular areas within ITS, such as the charging of electric vehicles, V2X communication, and a number of other mobility solutions. Many studies have been highlighted by these analyses and reviews. They have been rather successful in their analysis, giving just broad, overarching numbers of articles and the many subject areas covered. Even though these studies have shed light on the topic at hand, a more thorough evaluation of the ITS and road safety literature using rigorous bibliometric approaches might provide even more nuanced findings. Focusing on the intersection between road safety and ITS, this study provides a systematic analysis of the topic. This research began with a database of more than 709 published articles and narrowed it down to identify more significant works and investigators since "ITS" is a generic word that may apply to a wide range of papers. This study focuses on the depth and breadth of studies conducted over the last three decades.

2. Methodology and materials

A thorough evaluation of the existing body of knowledge is essential for spotting research gaps and elucidating the limits of a certain field of study. Literature reviews are usually done in a cycle that starts with defining relevant search terms, moves on to choosing relevant material, and ends with an analysis [54].

Rowley and Slack proposed a methodical process for gathering relevant information, which included looking for relevant articles, scanning them for key concepts, organizing the material using mind mapping, and ultimately, writing and compiling a bibliography [55,56]. To achieve this goal, initially, an overview of the ITS is provided, followed by a review of the literature on how the ITS may be used to improve traffic safety. Noting that the ITS has only been around for a few decades, we set out to demonstrate how much technology has contributed to improving road safety after three decades. Thus, the time frame covered by this analysis is from January 1991 through December 2022. In this work, we thus offer both qualitative and quantitative analyses by analyzing all papers and publications on the Web of Science (WOS) platform pertaining to road safety and ITS.

2.1. Quantitative analysis

The quantitative examination of the SCI is conducted in a methodical manner, starting in 1992 and ending in December 2022. As previously stated, a quantitative review of the application of ITS to road safety is conducted. For the quantitative evaluation, the search terms "road safety" and "intelligent transportation systems" are both chosen as search terms. This search was narrowed to the topic in order to give priority to scholarly literature. Authorship, international cooperation patterns, citation counts, and reprint author addresses were among the variables examined. For the citation analysis, the Journal Citation Reports (JCR) and Citations per Publication (CPP) were used, and the impact ctorfa was the deciding factor.

2.2. Qualitative analysis

Qualitative analysis that is both deep and intricate is conducted using the historical approach [57,58]. Exploring the times, locations, and circumstances in which events take place and evolve is helpful in this form of study. In this research, we take a qualitative examination of how ITS has been used to improve road safety over the last three decades. A conclusion on how ITS may be used in further projects is provided based on the findings.

3. Intelligent transportation systems

There are numerous issues related to urban and rural management that have arisen because of the rise in the number of cars and the urban and rural populations, including the waste of time and money, the endangerment of drivers and pedestrians, and the contamination of the air and water. Living standards continually decline while fossil fuel use rises. Meanwhile, the transportation sector has undergone significant transformation as a direct result of the rising need for mobility. The infrastructure of a country's transportation is now a big part of how its economy grows [59–61]. Intelligent Transport System (ITS) is one of the most important phenomena that has helped engineers and researchers in the transportation industry in the last few decades. Next-generation technology development in transportation engineering is often referred to as ITS. Nowadays, it's more crucial than ever to have a well-designed ITS. The availability of efficient and secure modes of transportation is one of the most fundamental infrastructures required for the growth and improvement of social welfare in every country. In fact, ITS is one of the most important indicators for making cities smart [62,63].

The contribution of the ITS to road safety is crucial. ITS are state-of-the-art applications whose main goal is to make it easier to offer new services in transportation and traffic management. The end result is that users are better informed and can use existing transportation infrastructure in a safer, more coordinated, and "smarter" way. However, ITS isn't limited to use on highways. In addition to aiding in navigation, it also functions to improve air, sea, and railway systems [64]. There is a wide range of technologies used in ITS, from basic management systems like GPS and traffic lights to monitoring applications like CCTV and automatic incident detection or stopped vehicle detection to more complex ones like parking guidance that integrate real-time data and feedback from multiple sources [65]. Increased transport efficiency, fewer accidents, higher levels of safety, and lessened congestion are just some of the benefits that may be gained by using ITS.

4. Results and discussion

4.1. Evaluation of publications and citations

Using information from the Web of Science that goes back three decades, from the 1990s to December 2022, 709 publications were found. Figure 1 displays a histogram of annual publication counts. Figure 1 shows the distribution of articles published in various years, and it is obvious that 87 publications made up the bulk of the total in 2021. As of January 1, 2022, there have been 56 publications published on the issues of "road safety" AND "intelligent transportation systems" in that time frame. Figure 1 shows that the total number of papers released each year has been on the rise since 1996, with the exception of 2019 and 2022, when the number of documents published each year fell. In this case, there can be many reasons; we mention two of the most probable ones. Issues such as the world's confrontation with the COVID virus, which has affected many aspects of human life, including academic issues, can be considered one of the most important reasons for increasing the time of investigations and reducing the number of projects and the publication of articles. It can also be pointed out that the decrease in published research in 2022 could be due to the change of keywords ("road safety" and "intelligent transportation systems") in 2022 and that researchers used other new keywords instead. Even though the number of papers published each year on "road safety" and "intelligent transportation systems" has changed over the last ten years, it is safe to say that these terms have become important in the world of scholarly publishing. This is because the topics are new, and technology has improved in recent years.

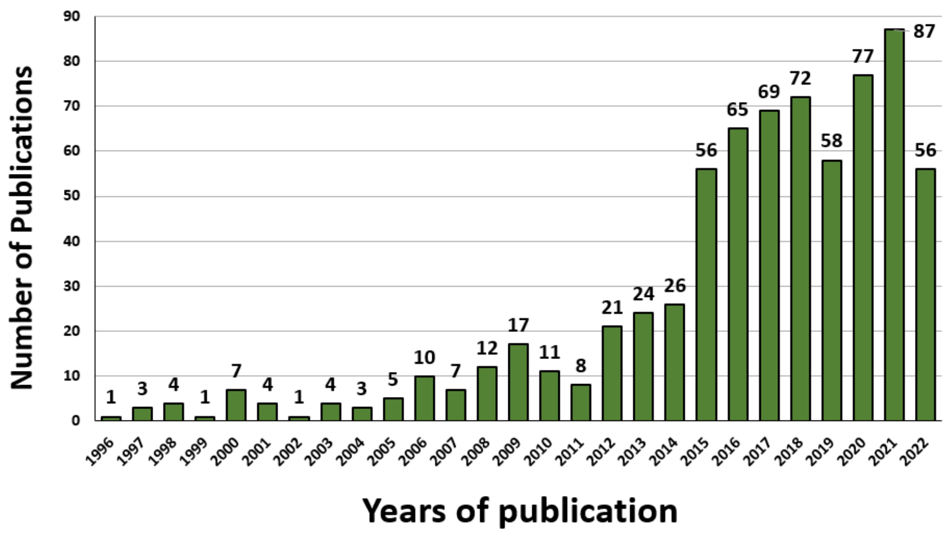

Fig. 1. The number of documents published every year from the 1990s to the end of 2022.

The number of citations acquired from the Web of Science was equivalent to 6508 citations, the distribution of which is illustrated in Figure 2. The year with the most citations was 2022, with 1351 citations, which is appropriate for this era. The citation trend shows that researchers are referring to this topic in more and more papers. This is related to issues such as the novelty and importance of the subject, which have attracted the attention of many researchers. Eq. 1 is a polynomial equation that describes the relationship between the number of citations and the number of years, and it has a correlation of 0.91. This association predicts a rising trend in citations over the next several years. As shown in Eq. 2, Y is the total number of citations, and X is the year.

$$Y = 4.0433x^2.16206x + 2E + 07 \quad (1)$$

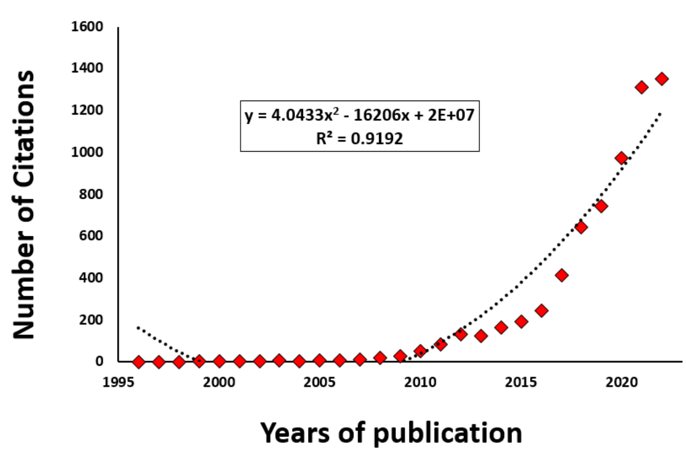

Fig. 2. The number of documents published every year from the 1990s to the end of 2022.

4.2. Evaluating by research area, source topics, and document types

Figure 3 displays the distribution of printed material by subject area, with 269 documents pertaining to the subfield of Engineering Electrical Electronic. There have been 204 papers published in the subject of transportation science and technology, making it the second most productive field out of ten based on the web of science categories. Researchers have made direct use of the term "ITS for road safety" in their titles, abstracts, and keywords of publications relating to this issue. Another indicator of academic enthusiasm for applying ITS to traffic security is the high volume of papers published in the area of electrical and electronic engineering. More than half of all technical publications are in the first three categories, which include fields including engineering, electrical and electronic, transportation science and technology, and telecommunications. Meanwhile, over the same time period, a total of 146, 99, 85, and 85 documents were published in the fields of computer science information systems, computer science theory and techniques, computer science artificial intelligence, and transportation, respectively. Since the ITS has a lot of potentials to make roads safer and these four groups cover such a wide range of issues, it was thought that more papers would be written about these topics.

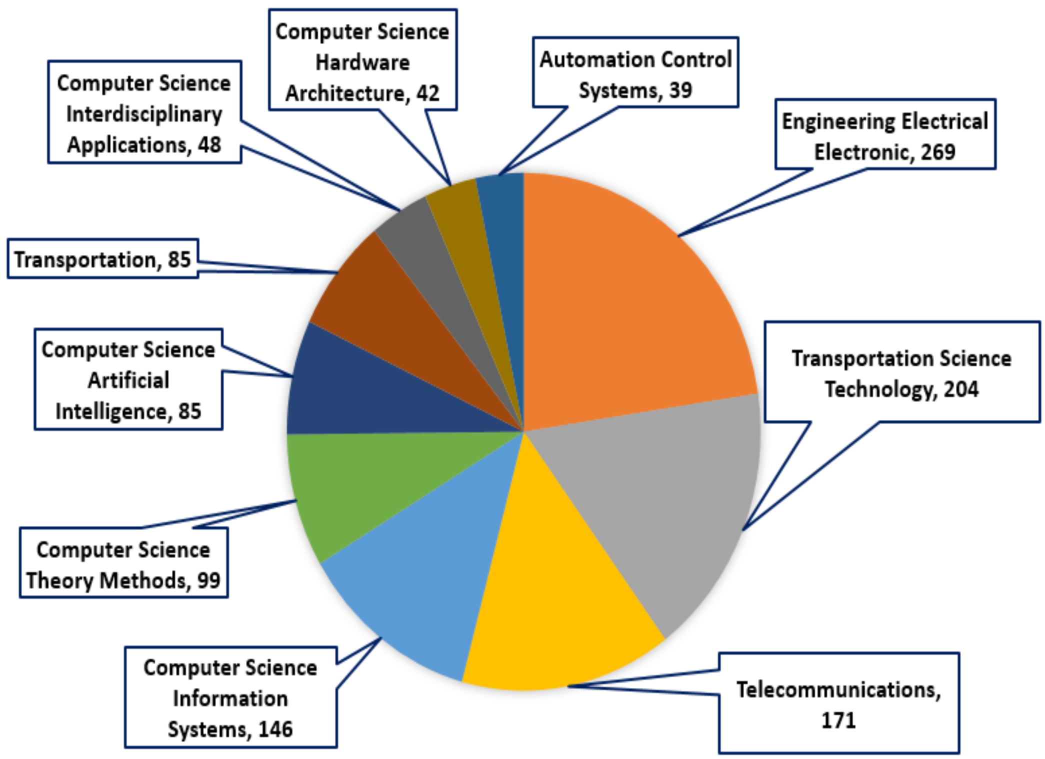

Fig. 3. Research area of road safety and ITS from the 1990s to the end of 2022.

Figure 4 shows the distribution of document types during the three-decade span from the 1990s to 2022. According to the data gathered, the Proceeding Papers contributed the most, accounting for 354 of all other published publications. As evidence of the study's importance and prominence, nearly 48% of the studies were presented as proceeding papers. The article's focus on ITS's positive impact on road safety was also encouraging. At the other end of the participation spectrum, the number of keywords used was much lower than predicted in the Early Access and Editorial Material categories (at 8 and 3, respectively).

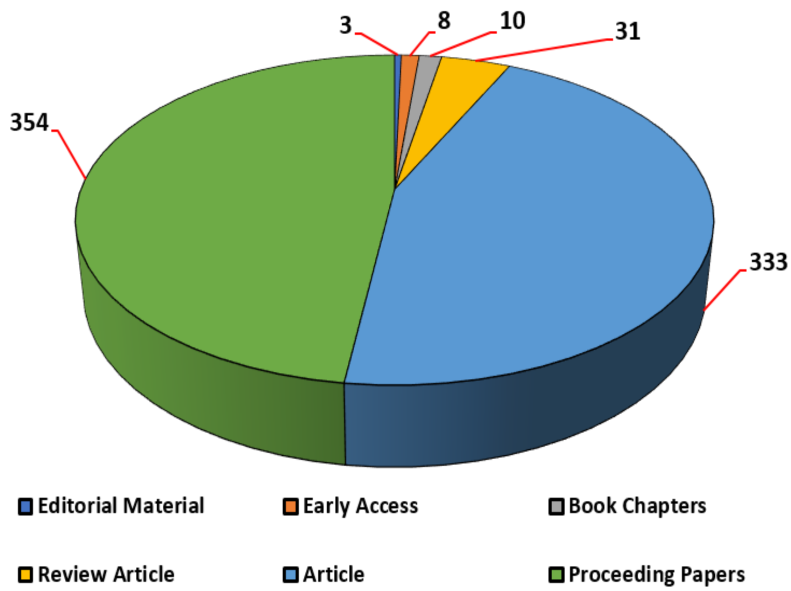

Fig. 4. Category of Printed documents from the 1990s to the end of 2022.

Publication titles were retrieved from the Web of Science database and are included in Table 1. In practice, the top 10 journals, all of which are part of the Web of Science core collection, provide separate data for the total number of published documents and the proportion of those documents that were cited. About 3.25 percent of all published works are found in the IET Intelligent Transport Systems. After that, IEEE Access was the second journal, which had 21 articles. The next journal was the Sensors journal from MDPI. Twenty papers were published in this journal, making it the third most popular, and authors often cite the Intelligent Transportation System (ITS) and road safety in their work. Statistics revealed that three prestigious publishers (IEEE, Elsevier, and Springer Nature) were responsible for publishing almost 60% of the articles in the journals studied.

Table 1
Publication Titles from the 1990s to the end of 2022.

No.	Publication Titles	Record Count	% of 709
1	IET Intelligent Transport Systems	23	3.25
2	IEEE ACCESS	21	3
3	Sensors	20	2.8
4	IEEE Transactions on Intelligent Transportation Systems	15	2.1
5	Transportation Research Procedia	15	2.1
6	Communications in Computer and Information Science	12	1.7
7	Accident Analysis and Prevention	11	1.5
8	IEEE Vehicular Technology Conference Proceedings	11	1.5
9	IEEE International Conference on Intelligent Transportation Systems ITSC	9	1.2
10	Applied Sciences Basel	8	1.1

4.3. Top ten authors and countries

Table 2 shows the most cited authors and the total number of publications in the top ten countries for ITS and road safety. In this time frame, Liu and Zhang had the most pa-pers published (6). Also, on the list of most-cited writers are names like Leden, Scholliers, Rakotonirainy, Kalasova, Silla, Oskarbski, and Jarasuniene, each of whom has written five studies. Jimenez rounded out the top 10 with four publications. When comparing nations that have released information related to road safety and ITS, France comes out on top with 67 papers, followed by India (64) and England (57). With 30 printed documents, the United States had the most documents related to road safety and ITS at the end of the top ten countries list.

Table 2
Top ten Authors and Countries from the 1990s to the end of 2022.

Top ten Authors			**Top ten Countries**		
Authors	**Record Count**	**% of 709**	**Countries**	**Record Count**	**% of 709**
Liu, Enjie	6	0.85	FRANCE	67	9.45
Zhang, Sijing	6	0.85	INDIA	64	9.03
Leden, Lars	5	0.7	ENGLAND	57	8.04
Scholliers, Johan	5	0.7	PEOPLES R CHINA	51	7.2
Rakotonirainy, Andry	5	0.7	SPAIN	45	6.35
Kalasova, Alica	5	0.7	AUSTRALIA	37	5.22
Silla, Anne	5	0.7	RUSSIA	34	4.8
Oskarbski, Jacek	5	0.7	GERMANY	32	4.51
Jarasuniene, Aldona	5	0.7	POLAND	31	4.37
Jimenez, Felipe	4	0.7	USA	30	4.23

4.4. An overview of top ten papers

One more analysis looked at the top ten most-cited papers by analyzing their authorship, titles, journals, document types, citation counts, and annual citation rates. Table 3 displays these findings. As was previously indicated, the great majority of road safety and ITS-related documents were produced as proceeding papers. However, this trend is clearly seen among the most cited papers, where the vast majority of documents come from articles. Table 3 shows that there was a total of 10 papers, 9 of which were articles. Abboud et al. (2016) is the most-cited paper, with 360 citations between December 2016 and November 2022 (an annual average of 45.13 citations). They published their research in the Transactions on Vehicular Technology journal, which belongs to the Institute of Electrical and Electronics Engineers (IEEE), Inc [66]. The work by Lei et al. (2017) ranked second on the list of the 10 most cited publications, with 304 citations in total and 43.57 citations per year on average [67]. So, looking at the most-cited papers shows that, on average, most of these articles were cited more than 10 times per year. Also, in Table 4, an overview of the methodology, results, and findings is provided, and keywords in the top 10 referenced articles are examined.

Table 3
Top 10 most cited papers from the 1990s to the end of 2022.

Authors	Title	Journal	Document type	Number of citations	Average citation per year
Abboud et al., [66]	Interworking of DSRC and Cellular Network Technologies for V2X Communications: A Survey	IEEE transactions on vehicular technology	Article	360	45.13
Lei et al., [67]	Blockchain-Based Dynamic Key Management for Heterogeneous Intelligent Transportation Systems	IEEE Internet of Things Journal	Article	304	43.57
Stanton, and Salmon [68]	Human error taxonomies applied to driving: A generic driver error taxonomy and its implications for intelligent transport systems.	Safety Science	Article	173	11.67
Rahman et al., [69]	Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems.	Accident Analysis & Prevention	Article	140	20.43
Liu et al., [70]	Predicting driver drowsiness using vehicle measures: Recent insights and future challenges.	Journal of safety research	Article	142	9.47
Bali et al., [71]	Clustering in vehicular ad hoc networks: taxonomy, challenges and solutions.	Vehicular communications	Article	124	12.4
Wang et al., [72]	Parallel driving in CPSS: A unified approach for transport automation and vehicle intelligence.	IEEE/CAA Journal of Automatica Sinica	Article	120	17.14
Zaklouta, and Stanciulescu [73]	Real-time traffic sign recognition in three stages.	Robotics and autonomous systems	Article	97	9.8
Eze et al.,[74]	Vehicular ad hoc networks (VANETs): Current state, challenges, potentials and way forward.	In 2014 20th international conference on automation and computing IEEE	Proceeding Papers	93	9.3
Pauzié [75]	A method to assess the driver mental workload: The driving activity load index (DALI).	IET Intelligent Transport Systems	Article	88	5.5

Table 4
Overview top ten papers in road safety and ITS [53-62].

No.	Method	Key finding /result	keywords
1	Dedicated short-range communications (DSRC) and cellular networks technologies for efficient Vehicle-to-anything (V2X) communications	In an effort to harmonize academic and industrial operations in the automotive sector, they offered an overview of worldwide DSRC standards, current V2X research and development platforms, and V2X products already accepted and implemented in cars by car manufacturers. Based on how well DSRC and cellular network technologies work together, they suggested a few open research questions for future V2X communications.	Cellular radio, mobility management (mobile radio), research and development
2	The blockchain concept for heterogeneous VCS domains.	The effectiveness and efficiency of the proposed framework were demonstrated through extensive simulations and analysis. In terms of how long it took to transfer keys, the structure with a central manager was worse than the structure with a blockchain, and the dynamic scheme made it possible for SMs to adapt to different levels of traffic.	Vehicle dynamics, Internet of Things, Heterogeneous networks, Intelligent vehicles, Cryptography, Privacy, Handover, Vehicular ad hoc networks
3	Analysis of the literature on the topic of driver mistake in vehicular transportation. Norman, Reason, and Rasmussen, three pioneers in the study of human error, are specifically examined.	All but one of them did not use a taxonomy of human error. Therefore, a general driver error taxonomy was developed using the most prominent psychological processes known to play a role in driver error. Perception, attention, situation evaluation, planning, intention, memory, recall, and action execution are all parts of these processes.	Human error, Driver error, In-car technology, Error taxonomy
4	A driving simulator approach (Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT)) and an online survey approach.	All three models (TAM, TPB, and UTAUT) were shown to be able to explain at least 71% of the variation in behavioral intention with their suggested sets of components, which in turn helped explain driver acceptability. TAM was determined to be the most effective model for predicting driver satisfaction, followed closely by TPB. The results of this research show that these models are suitable for use with Advanced Driver Assistance Systems.	Driver acceptability, Driver behavior, Driver attitude, Vehicle automation, Intelligent transport systems
5	By reviewing and analyzing the articles in the article database, criteria for a vehicle that can predict drowsiness in real time were evaluated.	Drowsiness may seriously impair driving ability in controlled, experimental circumstances, according to many behavioral investigations. However, the majority of that research focused on basic performance functions (such as the standard deviation of lane position), and the outcomes were often presented as averages across drivers and across time.	Fatigue, Sleepiness, Lane position, Steering wheel, Intelligent Transport Systems
6	Based on different factors, a comprehensive taxonomy including challenges, limitations, and solutions for clustering in Vehicular Ad Hoc Networks (VANETs) was provided.	Users working in this field may choose one of the suggestions based on its advantages above the others thanks to the analysis offered for numerous current plans.	Vehicular ad hoc networks, Clustering, Data dissemination, Routing
7	Parallel Driving and a cloud-based cyber physical-social systems (CPSS) framework aiming at synergizing connected automated driving were used.	Parallel driving was a promising idea to make sure that in the future, connected automated cars with different levels of automation can work together in a way that is smooth, safe, and effective.	Automation, Vehicles, Testing, Trajectory, Learning (artificial intelligence), Road Transportation

8	An efficient linear Support Vector Machine (SVM) with a Histogram of Oriented Gradients (HOG) features were used for detection. Also, the tree classifiers, K-d tree, and Random Forest, identify the content of the traffic signs found.	They demonstrated that, for the German Traffic Sign Recognition Benchmark (GTSRB), just a subset of around one-third of the characteristics is enough to achieve a high level of classification accuracy.	Traffic Sign Recognition (TSR), Advanced Driver Assistance Systems (ADAS), Intelligent transport systems, Color segmentation, Feature space reduction, German Traffic Sign Recognition Benchmark (GTSRB)
9	Using an overview of current research, challenges, and potentials of Vehicular ad hoc networks (VANETs).	After examining various references, several conclusions and suggestions for future actions were presented. Also, they discovered that the methodical introduction and public acceptance of this new technology are just as crucial and significant as the recent technological progress.	Vehicles, Vehicular ad hoc networks, Wireless communication, Reliability, Communication system security, Standards
10	Six pre-defined factors were given a scale rating procedure, which was followed by a weighting procedure to combine the six individual scales into a single global score.	A possible improvement to the design would be to add criteria related to certain parts of driving that help figure out how well-advanced driver assistance systems (ADAS) features work.	Behavioral sciences computing; Automated highways; Road safety; Traffic engineering computing

By studying the literature and examining the growth trend of studies and the citations to these studies, it was clearly shown that there is good potential in the field of ITS and road safety research. But there are always limitations and problems that can make extensive research in this field difficult. Among these problems, the cost of purchasing and installing smart systems can be mentioned. We can also mention the expertise required in interpreting the results obtained from this smart tool. But with the growing trend of technology, it is hoped that in the coming years, the costs will be reduced to a great extent and there will be more training platforms for the installation and operation of these systems for operators. Also, more specialists should receive the necessary training in this field. This can undoubtedly provide the basis for more studies.

5. Conclusions

In this study, the application of the ITS in road safety from the 1990s to 2022 was reviewed. To that end, the use of ITS in road safety during this time period was reviewed and evaluated using the WOS platform. According to the reviews, the number of citations in articles related to these keywords is increasing. In addition, more than half of the documents were proceeding papers, and according to the WOS categories, more than half of the documents were from three of the most major publishers: IEEE, Elsevier, and Springer Nature. Researchers from many different fields have found that ITS makes roads safer and is generally well-liked based on their studies and evaluations. The results of this study showed that papers presented in many subfields of ITS were new. They focused on road safety, and publications that used ITS to analyze things were often cited. Given the ITS's great efficiency, the rising trend of citations to works connected to this system, and its major contribution among respected publications, it is advised that researchers employ the ITS as a strong and resilient instrument in addressing diverse transportation challenges. Finally, it should also be mentioned that there are still many obstacles in the field of studies on the use of ITS in road safety, including the high costs of equipment. This can cause some problems in studies in this field. But with the rapid advances in technology, it is hoped that the cost of tools and testing equipment for ITS will decrease in the coming years, which will help further studies.

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Conflicts of interest

The authors declare no conflict of interest.

Authors contribution statement

Conceptualization, G.G. and S.S.H.; methodology, G.G. and S.S.H.; software, S.S.H.; formal analysis, S.S.H.; investigation, S.S.H.; resources, G.G, V.A, A.V.; writing—original draft preparation, G.G. and S.S.H.; writing—review and editing, G.G, S.S.H, V.A, A.V.; supervision, G.G., V.A., A.V., ZWG. All authors have read and agreed to the published version of the manuscript.

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